

**IN THE UNITED STATES DISTRICT COURT  
FOR THE DISTRICT OF DELAWARE**

SIEMENS MEDICAL SOLUTIONS USA, INC.,	)	
	)	
	)	
Plaintiff,	)	
	)	C.A. No. 07-190 (SLR)
v.	)	
	)	<b>REDACTED VERSION</b>
SAINT-GOBAIN CERAMICS & PLASTICS, INC.,	)	
	)	
	)	
Defendant.	)	

**AFFIDAVIT OF MARVIN J. WEBER**

MORRIS, NICHOLS, ARSHT & TUNNELL LLP  
Jack B. Blumenfeld (I.D. No. 1014)  
Maryellen Noreika (I.D. No. 3208)  
1201 North Market Street  
P.O. Box 1347  
Wilmington, DE 19899  
(302) 658-9200  
[jblumenfeld@mnat.com](mailto:jblumenfeld@mnat.com)

*Attorneys for Plaintiff  
Siemens Medical Solutions USA, Inc.*

*Of Counsel:*

Gregg F. LoCascio  
Charanjit Brahma  
Sean M. McEldowney  
KIRKLAND & ELLIS LLP  
655 15th Street, N.W., Suite 1200  
Washington, D.C. 20005-5793  
(202) 879-5000

Original Filing: July 9, 2007  
Redacted Filing: July 16, 2007

**IN THE UNITED STATES DISTRICT COURT  
FOR THE DISTRICT OF DELAWARE**

SIEMENS MEDICAL SOLUTIONS USA, INC.,	)	
	)	
Plaintiff,	)	
	)	Civil Action No. 07-190 SLR
v.	)	
	)	<b>Jury Trial Demanded</b>
SAINT-GOBAIN CERAMICS & PLASTICS, INC.,	)	
	)	
Defendant.	)	

**AFFIDAVIT OF MARVIN J. WEBER**

I, Marvin J. Weber, hereby declare:

**I. BACKGROUND AND CREDENTIALS**

1. I have been involved in the study of condensed matter physics and materials science for more than fifty years. I am presently engaged in research as a member of the Department of Nuclear Medicine and Functional Imaging of the Life Sciences Division at the Lawrence Berkeley National Laboratory, and my research focus involves the use of scintillator materials for medical imaging.

2. I received my A.B., M.A., and Ph.D degrees in physics from the University of California, Berkeley, writing my dissertation on magnetic resonance and condensed matter physics. After my graduation in 1959, I joined the Research Division of the Raytheon Company as a Principal Scientist. During my time at Raytheon, my group developed many

new rare-earth laser materials and discovered luminescence in bismuth germanate, a scintillator crystal widely used for the detection of high-energy particles and radiation.

3. In 1973, I joined the Laser Fusion Program at the Lawrence Livermore National Laboratory (LLNL). As Head of Basic Materials Research, I had responsibility for the physics and characterization of optical materials for high-power laser systems used for inertial confinement fusion research with activities including optical spectroscopy, nonlinear optics, and magneto-optic properties of crystals and glasses.

4. In 1987, I became principal liaison and spokesperson for the University of California/National Laboratories research facilities at the Stanford Synchrotron Radiation Laboratory. I was also appointed Associate Division Leader for Condensed Matter for the Chemistry and Materials Science Department, a position I held until my retirement in 1993. In 1993, I received the International Conference on Luminescence Prize in recognition of my "fundamental studies of dynamic processes in solids which affect luminescence efficiency and application of that knowledge to laser and scintillator materials."

5. Subsequent to my retirement from the LLNL, I continue to conduct research as a member of the Department of Nuclear Medicine and Functional Imaging of the Life Sciences Division at the Lawrence Berkeley National Laboratory. I have also served as Editor-in-Chief of the CRC Handbook Series of Laser Science and Technology and as Associate Editor of the Journal of Luminescence. Additionally, I have acted as a consultant for several governmental and industrial research organizations.

6. Additional information concerning my background and qualifications is set forth in my resume, which is attached as Exhibit A.

## **II. BASIS FOR OPINION**

7. In preparing this affidavit, I reviewed U.S. Patent No. 4,958,080, the prosecution history for that patent, the Declaration of Niraj Doshi prepared for this suit, the test results included in the Declaration of Niraj Doshi, and various technical articles. A complete list of the documents I considered is included as Exhibit B. My opinions are based on my review of these documents and my knowledge as an expert in the field of scintillation.

## **III. SCOPE OF OPINION AND LEGAL PRINCIPLES APPLIED**

8. It is my understanding that Siemens has alleged that certain PET/CT scanners marketed by Philips under the brand names “Gemini TF” or “Gemini Raptor” infringes the ‘080 patent. It is also my understanding that Siemens has alleged that the scintillation crystals used in the PET portion of those scanners is and has been obtained by Philips from Saint Gobain.

9. Based on my review of Philips 501(k) submission to the FDA and its marketing brochures regarding the Gemini TF scanner, it is my understanding that they incorporate LYSO scintillation crystals. I have also reviewed information product literature from Saint Gobain regarding its LYSO crystal, which is marketed under the brand name PreLude 420.

10. It is my understanding that, in order for these Philip scanners to infringe the ‘080 patent asserted by Siemens, they must satisfy each of the elements of at least one claim of the ‘080 patent, and that an element may be satisfied either literally or under the doctrine of equivalents.

11. It is my understanding that there is no genuine dispute that the accused Philips scanners include “gamma ray detectors” and a “photodetector,” and, therefore, satisfy those elements of claims 1 and 2 of the ‘080 patent. Accordingly, I have focused my analysis in this affidavit on

the “scintillator” element of these claims and whether that element is satisfied under the doctrine of equivalents as Siemens contends.

12. I understand that one way to show that the LYSO crystals in Philips’s scanners are “equivalent” for purposes of infringement under the doctrine of equivalents is to show that Saint-Gobain’s crystal performs substantially the same function, in substantially the same way to achieve substantially the same result as the “scintillator” element in claim 1 (the “function-way-result” test). It is also my understanding that the appropriate functions, ways, and results to consider in comparing the claimed element and the allegedly equivalent feature of Philips scanners are the ones described in the patent and its prosecution history.

13. I further understand that another test for equivalence – the “known interchangeability” test – is whether Saint-Gobain’s LYSO crystals were known to be interchangeable with the LSO crystals described as an element of the ‘080 patent claims at the time of the alleged infringement (*e.g.*, when Saint-Gobain supplied Philips with the LYSO crystals for its Gemini TF or Raptor PET/CT scanners).

14. Based on the information I have seen regarding Saint-Gobain’s LYSO crystals and the ‘080 patent, as well as my own knowledge of the field of scintillation physics and the various references identified below, it is my opinion that Saint-Gobain’s LYSO crystals are equivalent to the claims LSO crystals under either the “function-way-result” test or the “known interchangeability” test. For this reason, I conclude that the Philips Gemini TF or Gemini Raptor PET/CT scanner infringes the claims of the ‘080 patent.

15. In considering the issue of infringement, I have interpreted the claims as I believe a person of ordinary skill in the field of scintillation physics would read them, and, when

applying the doctrine of equivalents, I have applied my understanding of what a person of ordinary skill in this field would understand to be “equivalent” or “substantially similar.”

#### IV. INTRODUCTION TO SCINTILLATION

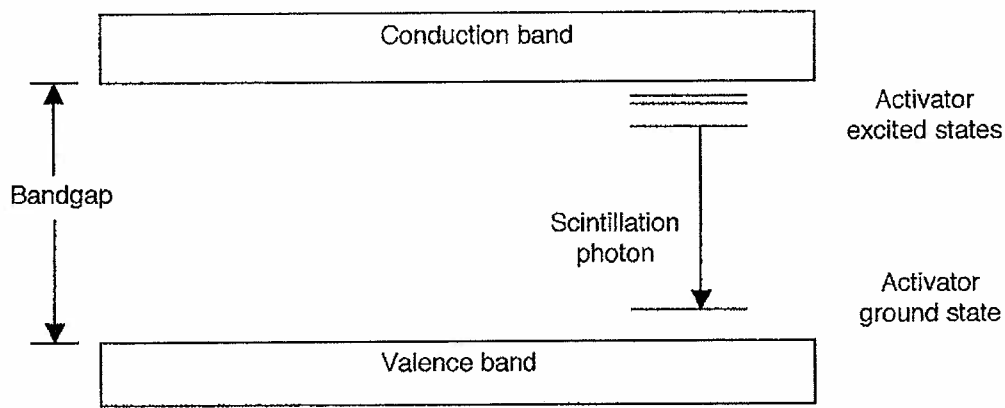
16. Scintillation is an example of radioluminescence wherein the absorption of high-energy radiation produces observable light. Scintillators may be organic or inorganic solids (insulators and semiconductors), liquids, or gases and may be either intrinsic (self-activated) or extrinsic (activated by dopant ions, impurities added in small amounts to a substance to create luminescent centers). The most widely used scintillators are transparent inorganic crystals. The crystals of the '080 patent and Saint-Gobain's PreLude 420 crystals are both cerium-activated rare-earth oxyorthosilicate crystals, which are extrinsic inorganic scintillators.

17. High-energy radiation such as a gamma ray interacts with a scintillation crystal by (1) absorption of a photon of the high-energy radiation incident on a crystal by inner shell electrons of atoms of the scintillator material (photoelectric effect), (2) Compton scattering of a gamma-ray photon with the creation of a recoil electron, and (3), for very high energies, by complete absorption of the photon and conversion into an electron-positron pair.

18. The physical processes leading to scintillation in inorganic solids, while complex, are now generally well understood. The basic process of scintillation may be divided into four stages: (1) absorption of the incident radiation, (2) conversion of the absorbed energy into a large number of excited electron-hole pairs by a complicated cascade process involving primary photoelectrons and secondary electrons and photons, (3) transfer of some fraction of the electron-hole energy to excitation of luminescence centers (activator ions) or

recombination centers, and (4) the luminescence process, i.e. emission of light by the luminescent center.

19. The latter stages of the scintillation process involve electrons and holes and activators. Whereas electrons of a single free-standing atom occupy atomic orbitals, which form a discrete set of energy levels, when a large number of atoms are brought together to form a crystalline solid, the electrons no longer form a discrete set of energy levels, but instead form into a set of continuous energy bands separated by an energy gap. The figure below depicts the band structure and the electronic energy levels of an activated crystal (adapted from Figure 8-6 reference [1], first edition).



As also explained at pages 254-256 of the first edition of reference [1], the lower energy band, the valence band, represents those electrons that are essentially bound at lattice sites; the higher energy conduction band represents those electrons that have sufficient energy to migrate throughout the crystal. The valence and conduction bands are separated by a forbidden band in which electrons are not found in the undoped crystal. Absorption of energy results in promotion of electrons from their normal position in the valence band across the

bandgap into the conduction band, thereby leaving a hole in the normally filled valence band. An activator ion added to a crystal creates energy levels within the forbidden gap. An activator electron in an excited state can de-excite, or “relax,” back to the activator ground state by a radiative process, thereby giving rise to a scintillation photon (i.e. emitted light), or by a nonradiative recombination process.

#### **IV. POSITRON EMISSION TOMOGRAPHY (PET) APPLICATIONS FOR SCINTILLATION CRYSTALS**

20. In positron emission tomography, the radioactive decay of an isotope injected into a patient’s body results in a positron that annihilates with an electron producing two high-energy gamma-ray photons emitted in opposite directions 180° apart. The 511-keV gamma rays are detected by scintillator crystals that convert them into visible photons measured with photodetectors. In a typical PET scanner, thousands of scintillator crystals are arrayed in a ring configuration surrounding the patient’s body to detect the gamma rays. PET exploits the collinear emission of gamma rays by imposing a coincidence requirement on detectors opposite each other: an event detected simultaneously in the two detectors implies that the annihilation took place somewhere along the line between the two points of detection. From the coincidence data, images are constructed which represent the three-dimensional distribution of the radioactivity.

21. Many factors enter into the efficiency of converting particle energy into detectable light and the overall usefulness of a scintillator crystal:

- **Attenuation length** (stopping power): The ability of a crystal to stop (absorb) incoming radiation rather than let it pass through the crystal with no interaction. Specifically, attenuation length is defined as the depth into the material where the intensity of the incident gamma rays falls to  $1/e$  ( $e = 2.718$ ) of its value at the crystal surface.



Attenuation length is minimized by maximizing the density and the effective atomic number of the crystal.

- **Density** ( $\text{g/cm}^3$ ): Mass per unit volume (grams per cubic centimeter) of the scintillator crystal. High density and high effective atomic number materials are almost universally desirable because increased stopping power reduces the amount of scintillator material needed.
- **Emission wavelength**: the wavelength (color) of the scintillation light emitted from the crystal. To maximize detection efficiency, this wavelength should match the wavelength region in which the photodetector (e.g., photomultiplier vacuum tube, solid-state photodiode) is most sensitive.
- **Light yield**: (emitted photons per MeV): The quantity of light produced in the scintillation process. Greater light yield results in a larger signal from a "detection event" compared to any background emission or noise and thus is one of the most important properties of a scintillator affecting measurement accuracy and spatial resolution.
- **Energy resolution**: The ability to resolve "detection events" from any background noise by distinguishing between scattered and unscattered gamma-rays on a photon by photon basis. Energy resolution is determined from the full-width-at-half-maximum (fwhm) of the energy spectrum.
- **Scintillation decay time**: A measure of the time-dependent decrease of scintillation. Fast signal rise and decay times are important for good timing, high counting rates, low dead time for data processing, and are essential for time-of-flight modes of operation.
- **Proportionality**: The light yield should be proportional to the incident energy over a wide range of energies. For many scintillator crystals there is a close relation between energy resolution and non-proportionality of light output versus energy.
- **Physical properties**: The crystal should be of high optical quality and transparent to the scintillation wavelength. The refractive index should be near that of glass ( $\sim 1.5$ ) to permit efficient coupling of the scintillation light to the photomultiplier tube or other light sensor. Good mechanical strength, absence of weak cleavage planes, and insensitivity to air, moisture, and light are desirable characteristics.

22. The first PET scanners built in the late 1970s were based on thallium-activated sodium iodide ( $\text{NaI:Tl}$ ) and bismuth germanate (BGO), an intrinsic scintillator. The development of cerium-activated lutetium oxyorthosilicate ( $\text{LSO:Ce}$ ) has resulted in a material with a combination of desirable properties for current PET scanners (high density, good stopping power for 511-keV photons, high light output, fast decay time, and good energy resolution).

Compared to BGO, it has a similar attenuation length but approximately four times higher light output and seven times shorter scintillation decay time. LSO:Ce has made possible PET cameras with improved performance characteristics.

## **V. SAINT-GOBAIN'S CRYSTAL IS EQUIVALENT TO THE CLAIMED CRYSTAL**

23. Lutetium oxyorthosilicate (LSO) crystals have a lattice structure composed of lutetium (Lu), silicon (Si), and oxygen (O) in proportions given by the general formula  $\text{Lu}_2\text{SiO}_5$ , that is, a formula unit with two lutetium atoms, one silicon atom, and five oxygen atoms. It is a 1:1 compound in the binary rare-earth silicate system composed of  $1 \text{ Lu}_2\text{O}_3 \cdot 1 \text{ SiO}_2$  [5]. Lutetium yttrium oxyorthosilicate (LYSO) crystals are composed of lutetium (Lu), yttrium (Y), silicon (Si), and oxygen (O) in proportions given by the general formula  $(\text{Lu}_{1-y}\text{Y}_y)_2\text{SiO}_5$ , where  $y$  denotes the amount of yttrium that has replaced lutetium in the formula unit. They have the same lattice structure, except that in an LYSO crystal, an yttrium atom is substituted for lutetium at some (in this case, 10%) of the sites normally occupied by lutetium. A  $y$  value of zero corresponds to no yttrium— $\text{Lu}_2\text{SiO}_5$  (pure LSO); a  $y$  value of one corresponds to no lutetium— $\text{Y}_2\text{SiO}_5$  (pure YSO). In fact such pure materials do not exist because there are always trace amounts of impurities in the materials. The proportions of silicon and oxygen to the remaining elements in the crystal remain constant at all values of  $y$ .

24. LSO, YSO, and LYSO crystals have identical crystallographic structures defined by the monoclinic space group C2/c (monoclinic crystals look like tetragonal crystals that have been skewed and having three unequal crystal axes  $a$ ,  $b$ ,  $c$ ). There are two Lu lattice sites in both LSO and LYSO with physically different arrangements of surrounding ions; one site ( $\text{Lu}_1$ ) has

seven nearest-neighbor oxygen ions and the other ( $\text{Lu}_2$ ) has six nearest-neighbor oxygen ions. LSO and LYSO are insulating crystals.

25. The abbreviation “LYSO” does not denote a specific chemical composition or proportion of lutetium to yttrium in the crystal, thus the use of the abbreviation LYSO to denote materials having vastly different proportions of Lu and Y is somewhat misleading. For instance, in U.S. Patent No. 6,624,420 (reference [12]) the general formulation  $\text{Ce}_{2x}(\text{Lu}_{1-y}\text{Y}_y)_2(1-x)\text{SiO}_5$  was used to describe a material with some Lu replaced by Y, with the amount of Y with respect of Lu specified by the variable y. The value of y in the general formula was considered to range from approximately 0.0001 (0.01% Y) to approximately 0.9999 (99.99% Y), effectively meaning that the range covers everything but pure LSO and pure YSO crystals.

26. By the “50% rule” of mineral nomenclature for solid solutions [reference 9, page 231], a material is named by the end member. If the percentage of yttrium in  $(\text{Lu}_{1-y}\text{Y}_y)_2\text{SiO}_5$  is less than 50%, the material would be described as LSO containing yttrium, LSO being the end member when y goes to zero. Similarly, if the percentage of yttrium in  $(\text{Lu}_{1-y}\text{Y}_y)_2\text{SiO}_5$  is greater than 50%, the material would be described as YSO containing lutetium, YSO being the end member when y goes to one.

27. Lutetium and yttrium are members of the so-called “rare earths” comprising the 14 lanthanides – lanthanum (La, element 57) through lutetium (Lu, element 71) in the periodic table – plus yttrium (Y, element 39) and scandium (Sc, element 21). Yttrium has an atomic number of 39 and an atomic weight of 88.9 compared to an atomic number of 71 and atomic weight of 175 for lutetium, making lutetium a much heavier atom. For 6-fold nearest-

neighbor-ion coordination, the ionic radii of the two ions are very similar: 0.86 Å for trivalent yttrium ( $Y^{3+}$ ) and 0.90 Å for trivalent lutetium ( $Lu^{3+}$ ).

28. Because trivalent rare earth ions have similar sizes and similar chemistry, lattice sites typically occupied by lutetium in an LSO crystal can instead be occupied substitutionally by yttrium or other rare earths. Positively charged rare-earth ions will not normally substitute at the oppositely charged oxygen ion sites within the lattice, nor will such ions be located at interstitial sites in the lattice. Thus, when yttrium is substituted for lutetium in LSO, it occupies the same lattice sites that would otherwise be occupied by lutetium.

29. The density of the material is important because it correlates to the crystal's ability to absorb incident gamma radiation. At high levels the substitution of yttrium for lutetium in the oxyorthosilicate structure can substantially alter the material density, which depends on the atomic weight of the constituents. But at the low levels of yttrium substitution associated with Saint-Gobain's crystal, the difference in density does not have a substantial effect on the properties of the crystal. LSO has a density of 7.41 g/cm<sup>3</sup> that decreases with decreasing lutetium content to a density of only 4.45 g/cm<sup>3</sup> for YSO [reference 6, page 756]. However, for an yttrium substitution level of only 10% – the level measured and advertised for Saint-Gobain's PreLude 420 crystals – the density only decreases to 7.1 g/cm<sup>3</sup>, a very small difference in terms of the gamma ray absorption characteristics of the crystal.

30. High levels of yttrium substitution could also theoretically alter the crystalline structure. While the overall shape of the unit cell remains the same because yttrium occupies sites otherwise occupied by lutetium, the unit cell dimensions may change. The monoclinic unit cell parameters (in nanometers) of LSO:Ce, LYSO:Ce, and YSO differ only slightly: a =

1.433,  $b = 0.667$ ,  $c = 1.032$  for LSO:Ce [6, 46],  $a = 1.426$ ,  $b = 0.665$ ,  $c = 1.025$  for LYSO:Ce (LYSO:Ce sample (1), table 1, appendix 1, Y=11%), and  $a = 1.443$ ,  $b = 0.673$ ,  $c = 1.041$  for YSO [46]. As a result there are only small differences in the spacing between component atoms in LSO:Ce, LYSO:Ce, and YSO crystal lattices. For example, the average rare earth-oxygen distances for LSO and YSO differ by less than 2% (table 2, reference [46]).

31. Cerium (Ce) is a rare earth having an atomic number of 58 and an atomic weight of 140. Trivalent cerium ( $\text{Ce}^{3+}$ ) has an ionic radius of 1.01 Å and can replace lutetium in LSO. The cerium-doped lutetium oxyorthosilicate crystal referred to in claim 1 of U.S. Patent No. 4,958,080 has a general formulation  $\text{Ce}_{2x}\text{Lu}_{2(1-x)}\text{SiO}_5$ , where the  $x$  value denotes the amount of cerium that has replaced lutetium [11]. Cerium-doped lutetium yttrium oxyorthosilicate (LYSO:Ce) as claimed in claim 1 of U.S. Patent No. 6,624,420 has a general formulation  $\text{Ce}_{2x}(\text{Lu}_{1-y}\text{Y}_y)_{2(1-x)}\text{SiO}_5$ , where  $x$  ranges from approximately 0.0001 to approximately 0.05 [12], where  $x$  is, again, the amount of cerium.

32. LSO and LYSO are both doped with cerium to produce scintillation emission in the blue-violet spectral region. The cerium atoms become part of the LSO and LYSO crystal lattices, replacing lutetium atoms in LSO and either lutetium or yttrium atoms in LYSO. The substituted cerium atoms are considered to be located in the same places in both crystal lattices.

## **VI. SAINT-GOBAIN'S CRYSTAL IS EQUIVALENT TO THE CLAIMED CRYSTAL**

33. Having reviewed the patent, its prosecution history, Saint-Gobain's product data sheets, and Niraj Doshi's affidavit, I conclude that Saint-Gobain's PreLude 420 LYSO crystal is equivalent to the LSO crystal "scintillator" element in claim 1 of the '080 patent.

34. Claim 1 of the '080 patent calls for "a scintillator composed of a transparent single crystal of cerium-activated lutetium oxyorthosilicate having the general formulation  $\text{Ce}_{2x}\text{Lu}_{2(1-x)}\text{SiO}_5$ , where x is within the range of from approximately  $2 \times 10^{-4}$  to approximately  $3 \times 10^{-2}$ ."

35. Saint-Gobain's product data sheets describe Saint-Gobain's crystal as a lutetium oxyorthosilicate scintillation crystal containing yttrium (the "PreLude 420 crystal"). The chemical composition testing described in Niraj Doshi's affidavit confirms that Saint-Gobain's crystal is a lutetium oxyorthosilicate containing yttrium. To be used as a scintillator, the crystal must be transparent; the Saint-Gobain's crystal is indeed transparent.

36. The data sheet shows that PreLude 420 is doped with cerium. According to laboratory test results, PreLude 420 is doped with approximately 600 parts per million cerium by weight ("ppmw"). In claim 1 of the '080 patent, the amount of cerium dopant in the crystal is defined in terms of "x", according to the chemical formula  $\text{Ce}_{2x}\text{Lu}_{2(1-x)}\text{SiO}_5$ . The claim literally covers x values in the range of from approximately  $2 \times 10^{-4}$  to approximately  $3 \times 10^{-2}$ . 600 ppmw cerium corresponds to an x value that is within the range identified by claim 1.

37. The only difference between the crystals is that the PreLude 420 contains a relatively small amount (10% by mole) of yttrium substituted for lutetium, as advertised in Saint-Gobain's product data sheet (showing a composition of  $\text{Lu}_{1.8}\text{Y}_{0.2}\text{SiO}_5$ ) and as the testing done for Siemens by an independent laboratory (as described in the Doshi Affidavit and the corresponding exhibits), which show 4% yttrium by weight.

38. This corresponds to slightly more than 10% yttrium substitution (by mole), which correlates well with the published stoichiometric formulation of LYSO from Saint Gobain, being  $\text{Lu}_{1.8}\text{Y}_{0.2}\text{SiO}_5$ . Using this formulation, one can calculate the percent weight contribution of Y in the LYSO and one would achieve a value of 4% as measured by the independent lab. The table below lists various percent weight of Y based on varying the x in the following stoichiometric formula:  $\text{Lu}_{2(1-x)}\text{Y}_{2x}\text{SiO}_5$ .

<b>x values</b>	<b>Total atomic mass</b>	<b>Weight % of Y in LYSO crystal</b>
0.00	457.98	0.00%
0.01	456.26	0.39%
0.02	454.54	0.78%
0.03	452.82	1.18%
0.04	451.09	1.58%
0.05	449.37	1.98%
0.06	447.65	2.38%
0.07	445.93	2.79%
0.08	444.21	3.20%
0.09	442.49	3.62%
<b>0.10</b>	<b>440.77</b>	<b>4.03%</b>
0.11	439.04	4.45%
0.12	437.32	4.88%
0.13	435.60	5.31%
0.14	433.88	5.74%
0.15	432.16	6.17%
0.16	430.44	6.61%
0.17	428.72	7.05%
0.18	426.99	7.50%
0.19	425.27	7.94%
0.20	423.55	8.40%



39. At this low level of yttrium substitution, any difference between LSO, as claimed, and Saint-Gobain's crystal is inconsequential and the two crystals perform exactly the same function, in exactly the same way to achieve substantially the same result.

40. The function of the PreLude 420 crystal is identical to the function of the crystal described in claim 1: to serve as a scintillator, which means that the crystals are used to emit detectable light when they are hit with gamma rays or x-rays. Saint-Gobain's data sheet confirms this, noting that the crystal is a "scintillation crystal."

41. The way that the crystals function is virtually identical. As noted above, the basic mechanism is the same for both scintillator crystals. By substituting a small amount of yttrium at crystal sites that would otherwise be occupied by lutetium, Saint-Gobain has not altered the way the crystal achieves scintillation in any material respect. As noted above, the scintillation mechanism is well understood, and that mechanism is not altered by adding yttrium to an LSO crystal. The spectroscopic properties (absorption and emission spectra, scintillation decay time) of the cerium dopant in LSO are determined in large part by the crystal field due to the nearest-neighbor oxygen ions and to a lesser extent by the more distant silicon, oxygen, and lutetium ions. Both lutetium sites in the rare-earth oxyorthosilicate lattice have very disordered local structures. Beyond the nearest-neighbor oxygen coordination shell are various lutetium, oxygen, and silicon ions. The environment of a cerium ion substituted for  $\text{Lu}_1$  out to a distance of 0.5 nm consists of 41 atoms of which 27 are oxygen, 9 are lutetium, and 5 are silicon; the environment of a Ce ion substituted for  $\text{Lu}_2$  out to distance of 0.5 nm consists of 41 atoms of which 28 are oxygen, 8 are lutetium, and 5 are silicon. The primary purpose of the lutetium and/or the yttrium in scintillation crystals is to provide a crystalline structure and to



provide stopping power for gamma rays or x-rays hitting the crystal so that the crystal absorbs the energy of the radiation. Because lutetium is heavier and has a higher atomic number, lutetium provides somewhat greater stopping power. However, substituting yttrium in only 10% of the sites occupied by lutetium in a LSO crystal will not significantly alter the stopping power of the crystal and so does not amount to a substantial difference between the “way” Saint-Gobain’s LYSO crystal and the crystal described in claim 1 act as scintillators.

42. The result obtained by using Saint-Gobain’s LYSO crystal is also substantially the same as the result obtained by the LSO crystals described in claim 1. Based on my understanding that the relevant “results” for purposes of a doctrine of equivalents analysis should be found in the specification of the ‘080 patent, the critical results for the crystal of claim 1 include light output, scintillation decay time, detector efficiency, and emission peak.

43. I have reviewed Niraj Doshi’s affidavit summarizing testing performed on samples of Saint-Gobain’s crystals. The relevant results from those tests are summarized below, along with the results listed in the ‘080 patent for the crystal of claim 1. To the extent there are differences in the data presented for LSO crystals in the ‘080 patent and in Siemens Medical’s subsequent testing, it is important to note that crystal growth and processing techniques have improved significantly since the time the ‘080 patent issued. Those improvements lead to slightly different material properties for LSO crystals grown and processed in the late 1980s compared to those grown and processed today. Thus, although the patent lists material properties and scintillation characteristics for the LSO of the claimed crystal, those results were, obviously, from tests on crystals grown and processed with the standard practices of the time. Consequently, I would expect some differences between the properties of LSO crystals

listed in the '080 patent and Saint-Gobain's LYSO crystals and Siemens Medical's more recent LSO crystals simply from the fact that Saint-Gobain's and Siemens Medical's crystals were, presumably, grown under current practices instead of 1980s practices. Because there is inherently some variability in the properties of LSO crystals and because Siemens Medical's commercial crystals appear to be covered by the "scintillator" limitation of the claims of the '080 patent, I have included data regarding the properties of those commercial crystals in my analysis.

44. Test results for Siemens Medical's current LSO crystals are included in Niraj Doshi's affidavit, and I have also included them in the table below.

	'080 Patent	Prelude 420	PreLude Test	Siemens Medical's LSO Sample Averages
Light Output	6.25 (75 relative to BGO=12)	32 (photons/keV $\gamma$ )	5.6-5.7 (564-573 relative to BGO=100)	[REDACTED]
Decay Time (ns)	41	41	39-40	[REDACTED]
Emission Peak for Gamma Excitation at 20° C (nm)	426-430	420	417-423	[REDACTED]
Emission Max for UV Excitation (nm)	393-395		~400	[REDACTED]
Density (g/cm <sup>3</sup> )	7.4	7.1	7.1	[REDACTED]
Energy Resolution	8.8-13%	8%	8.1-9.4	[REDACTED]

45. These results show only insubstantial differences between the performance of the crystals. Most notably, the results for Saint-Gobain's crystals and Siemens Medical's LSO

crystals are substantially the same for light output, decay time, emission peak, energy resolution, and attenuation length.

46. The emission spectra for the Saint-Gobain's crystal and the Siemens Medical's current LSO crystal also confirms that the spectroscopic properties of the crystals are substantially the same. The exhibits to Niraj Doshi's affidavit show emission and excitation spectra for the crystals. These spectra show no difference of any consequence for scintillation performance.

47. That the results obtained by Saint-Gobain's crystal are substantially the same as the results obtain by the crystal of claim 1 is not surprising in light of the fact that Saint-Gobain's crystal differs only by substituting 10% of the lutetium in a pure LSO crystal with yttrium. Previous studies of LSO and LSO containing yttrium suggest that the properties of these crystals are substantially the same. For instance, one study looked at the emission spectra associated with the room-temperature radioluminescence from x-ray excited LSO:Ce, YSO:Ce, and LYSO:Ce (10% Y) were found to be equal "within experimental error" and that their decay properties were "nearly identical". Cooke, et al. [7] (page 7361, third paragraph and page 7362, Figure 4). There are slight differences in density and effective atomic number because of the replacement of some lutetium by yttrium.

48. These results are also consistent with the well-understood scintillation mechanism for the crystals. As noted above, the spectroscopic properties (absorption and emission spectra, scintillation decay time) of the cerium dopant in LSO are determined in large part by the crystal field due to the nearest-neighbor oxygen ions and to a lesser extent by the more distant silicon, oxygen, and lutetium ions. The local environment of the cerium activator in  $\text{Ce}_{2x}(\text{Lu}_{1-y}\text{Y}_y)_2\text{SiO}_5$  will be different depending upon the amount of yttrium substituted for lutetium.

As an example, consider  $y = 0.1$  (10% yttrium). For a random distribution of yttrium, a cerium ion would have on the average only one yttrium ion within 0.5 nm. This would not be expected to produce any noticeable effect on the spectroscopic properties of  $\text{Ce}^{3+}$  as the bonding to the nearest-neighbor oxygen ions has the dominant effect. For a random distribution of yttrium in  $\text{LYSO}:\text{Ce}$  containing 5–10% yttrium, statistically some Ce ions may have more than one yttrium ion within 0.5 nm. In this case there may be expected to be other regions in the crystal devoid of yttrium within 0.5 nm of Ce ions. These regions would have local environments and scintillation properties effectively identical to that of  $\text{LSO}:\text{Ce}$ .

49. For these reasons, in my opinion, Saint-Gobain's crystals perform the same function, in the same way, to achieve substantially the same result as the scintillator element of claim 1 of the '080 patent. Thus, under the "function-way-result" test, Saint-Gobain's  $\text{LYSO}$  crystals appear to meet the "scintillator" limitation of claim 1 of the '080 patent under the doctrine of equivalents.

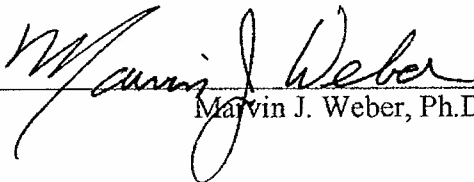
50. Saint-Gobain's  $\text{LYSO}$  crystals also seem to be equivalent when the "known interchangeability" test is applied. United States Patent No. 6,624,420 (the "Chai patent") claims as its invention  $\text{LYSO}$  crystals. The Chai patent acknowledges that "[c]ompared with all the other existing known scintillator crystals, Ce doped LSO [*i.e.*, the crystal claimed in the '080 patent asserted by Siemens] seems to have the best combination of all the needed properties for PET or other high energy gamma-ray detector application." [Chai patent, col. 2, ll. 41-44.] Notably, the Chai patent emphasizes that one of the goals in creating  $\text{LYSO}$  crystals was to "minimize the yttrium content to retain the LSO scintillating properties." [*Id.*, col. 4, ll. 30-32.] And in comparing  $\text{LYSO}$  crystals with various levels of yttrium substitutions, the Chai patent

shows that even at 30% yttrium substitution (described as “70% LYSO” in Table 1), LYSO crystals show only minor differences from LSO crystals in terms of light yield, energy resolution, effective Z, density, radiation length and phosphorescence. The Chai patent also notes that even levels of yttrium substitution approaching than 50%, important scintillation characteristics, such as light output, are unaffected. (*Id.*, col. 6, ll. 31-33 (“The light yield (or scintillating efficiency) remains constant for at least 50% percent [sic] substitution of lutetium with yttrium.”).)

51. As a result, in my opinion, Saint-Gobain’s crystals satisfy the “scintillator” element of claim 1 of the ‘080 patent under the “known interchangeability” test.

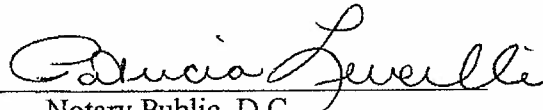
I hereby declare, under penalty of perjury, that the foregoing statements are true and correct to the best of my personal knowledge.

Date: June 25, 2007

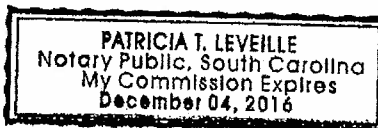
  
Marvin J. Weber, Ph.D.

District of Columbia: SS

Subscribed and sworn before me, in my presence, this 25 day of June, 2007.

  
Notary Public, D.C.

My commission expires \_\_\_\_\_.



**CERTIFICATE OF SERVICE**

I, the undersigned, hereby certify that on July 9, 2007, I electronically filed the foregoing with the Clerk of the Court using CM/ECF, which will send notification of such filing(s) to the following:

Jesse A. Finkelstein, Esquire  
Jeffrey L. Moyer, Esquire  
Kelly E. Farnan, Esquire  
Richards, Layton & Finger, P.A.

I also certify that copies were caused to be served on July 9, 2007 upon the following in the manner indicated:

**BY EMAIL & HAND**

Jesse A. Finkelstein, Esquire  
Jeffrey L. Moyer, Esquire  
Kelly E. Farnan, Esquire  
Richards, Layton & Finger, P.A.  
One Rodney Square  
Wilmington, DE 19801

**BY EMAIL**

Frederick L. Whitmer, Esquire  
Thelen Reid Brown Raysman & Steiner LLP  
875 Third Avenue  
New York, NY 10022

*/s/ Jack B. Blumenfeld*

---

Jack B. Blumenfeld (#1014)

**CERTIFICATE OF SERVICE**

I, the undersigned, hereby certify that on July 16, 2007, I electronically filed the foregoing with the Clerk of the Court using CM/ECF, which will send notification of such filing(s) to the following:

Jesse A. Finkelstein, Esquire  
Jeffrey L. Moyer, Esquire  
Kelly E. Farnan, Esquire  
Richards, Layton & Finger, P.A.

I also certify that copies were caused to be served on July 16, 2007 upon the following in the manner indicated:

**BY ELECTRONIC MAIL and HAND DELIVERY**

Jesse A. Finkelstein, Esquire  
Jeffrey L. Moyer, Esquire  
Kelly E. Farnan, Esquire  
Richards, Layton & Finger, P.A.  
One Rodney Square  
Wilmington, DE 19801

**BY ELECTRONIC MAIL**

Frederick L. Whitmer, Esquire  
Thelen Reid Brown Raysman & Steiner LLP  
875 Third Avenue  
New York, NY 10022

/s/ Maryellen Noreika (#3208)  
Maryellen Noreika (#3208)

# EXHIBIT A



## **Curriculum Vitae**

MARVIN JOHN WEBER

### **Education:**

A.B. Physics, University of California, Berkeley, 1954.  
M.A. Physics, University of California, Berkeley, 1956.  
Ph.D. Physics, University of California, Berkeley, 1959.

### **Professional Experience:**

1994 – Physicist, Department of Nuclear Medicine and Functional Imaging,  
Life Sciences Division, Lawrence Berkeley National Laboratory.

1973 – Physicist, Lawrence Livermore National Laboratory.  
1993  
Associate Division Leader for Condensed Matter,  
Chemistry and Materials Science Department, 1987–1993.

Spokesperson; University of California/National Laboratories,  
Stanford Synchrotron Radiation Laboratory, 1987–1993.

Transfer assignment, Office of Basic Energy Sciences,  
U.S. Department of Energy, Washington, DC, 1983–1985.

Head, Solid-State Laser Research Group, Laser Program,  
Assistant Program Leader, 1973–1983.

1959 – Principal Scientist, Manager – Solid State Lasers,  
1973 Research Division, Raytheon Company.

1966 – Visiting Research Associate, Physics Department,  
1967 Stanford University.

### **Professional Society Memberships:**

American Physical Society (Fellow)  
Optical Society of America (Fellow)  
American Ceramics Society (Fellow)  
Materials Research Society

### **Honors:**

International Conference on Luminescence Prize: 1993.  
George W. Morey Award, American Ceramics Society: 1983.  
Industrial Research IR-100 Award: 1979.  
Phi Beta Kappa, Sigma Xi (University of California, Berkeley).

**Consultant:**

CTI Molecular Imaging, Inc. 2005–2006.  
Multiphoton Phosphor Project, U. S. Department of Energy, 2001–2002.  
World Physics Technologies, Inc., 1996–97.  
Osram-Sylvania, 1995–1996.  
Corning, Inc., 1995.  
Battelle Pacific Northwest Laboratory, 1988–1995  
U. S. Department of Energy, Division of Material Sciences, 1986, 1992–94.  
Schlumberger–Doll Research, 1993–1994.  
Oklahoma Centers for Advancement of Science and Technology, 1992–1994.  
Consulting Professor, Stanford Synchrotron Radiation Laboratory, 1990–1992.  
Alcan International Limited, 1989.  
Research Institute, University of Dayton, 1980.  
National Science Foundation, Division of Materials Research, 1973–1975.

**Editor:**

Editor-in-Chief, *CRC Laser and Optical Science and Technology Series*, 1978–  
Associate Editor, *Journal of Luminescence*, 1984 –  
Associate Editor, *Journal of Optical Materials*, 1990–2004  
Regional Editor, *Journal of Non-Crystalline Solids*, 1987 –1995.  
Advisory Editorial Board, *Journal of Non-Crystalline Solids*, 1981–1987.  
Editorial Board, *Kvantovaya Elektronika*  
International Advisory Board, *Fizika i Khimiya Stekla*

**Conference Chairman/Co-Chairman:**

Co-chair, Scintillator Symposium, The Electrochemical Society, Phoenix, AZ, October 2000.  
  
Co-chair, High Energy Phosphor Symposium, The Electrochemical Society, Honolulu, October 1999.  
  
Fourth International Symposium on the Physics and Chemistry of Luminescence, Chicago, IL, October 1995.  
  
Physics and Chemistry of Scintillator and Phosphor Materials Symposium, Materials Research Society, San Francisco, CA, April 1994.  
  
International Symposium on Optoelectronic Materials, Honolulu, HI, November 1993.  
  
Scintillator Symposium, International Conference on Luminescence and Optical Spectroscopy of Condensed Matter, Storrs, CT, August 1993.  
  
Gordon Research Conference on Optical Phenomena in Glass, Tilton, NH, June 1992.

Gordon Research Conference on Glass, Tilton, NH, 1990.

Defects in Glasses Symposium, Materials Research Society, Boston, 1985.

Synchrotron Radiation Source Research and Development,  
U.S. Department of Energy Program Review, Ames Laboratory, 1984.

Theory and Computer Simulation of Materials Structures and Imperfections,  
Department of Energy Workshop, Michigan Technological University, 1984.

**Program Committee/Advisory Committee:**

Chair, Radiation Detection Materials Discovery Advisory Committee, Pacific Northwest National Laboratory, February 2005–present.

Inorganic Scintillators and Their Applications, SCINT07, Winston-Salem, NC, 2007; SCINT05, Alushta, Ukraine; SCINT03, Valencia, Spain; SCINT01, Chamonix, France; SCINT99, Moscow, Russia; SCINT97, Shanghai, Peoples Republic of China; SCINT95, Delft, The Netherlands.

VIII International Conference on the Physics of Non-Crystalline Solids, June 1995.

Fourteenth Conference on Crystal Growth, Fallen Leaf Lake, CA, June 1995.

Nuclear Sciences Symposium, Newport News, VA, November 1994.

Fifth International Otto Schott Colloquium, Jena, DDR, July 1994.

Thirteenth Conference on Crystal Growth, Fallen Leaf Lake, CA, June 1994.

Nuclear Science–Medical Imaging Conference, San Francisco, CA, November 1993.

International Workshop on Heavy Scintillators for Scientific and Industrial Applications, Chamonix, France, September 1992.

ALS Workshop on Synchrotron Radiation in Transactinium Research, Berkeley, CA, October 1992.

Optical Materials Symposium, Crystal City, VA, October, 1991.

VII International Conference on the Physics of Non-Crystalline Solids, Cambridge, England, August 1991.

International Conference of Point Defects in Glass, Riga, Latvia, July 1991

Twelfth Conference on Crystal Growth, Fallen Leaf Lake, May 1991.

Fourth International Otto Schott Colloquium, Jena, DDR, July 1990.

Eighth American Conference on Crystal Growth, Vail, CO, 1990.

Fourth International Conference on the Structure of Non-Crystalline Materials, Oxnard, CA, 1988.

Stanford Enhancement Project, Phase II, Stanford Synchrotron Radiation Laboratory, May 1986 and August 1988.

International Conference on Lasers, Lyon, France, 1987.

Second International Conference on Effects of Modes of Formation on the Structure of Glass, Nashville, TN, 1987.

International Workshop on Construction and Commissioning of Dedicated Synchrotron Radiation Facilities, Brookhaven National Laboratory, 1985.

International Conference on Tunable Solid State Lasers, La Jolla, CA, 1984.

International Quantum Electronic Conference: Los Angeles '84; Munich '82; Boston '80.

International Symposium on Rare Earth Spectroscopy, Wroclaw, Poland, 1983.

**Other Committees:**

International Conference on Luminescence Prize Committee (Chair): 2002, 1999, 1996.

Ives Metal Committee, Optical Society of America: 1998.

Fellows and Honorary Members Committee, Optical Society of America: 1995 – 1997 (Chair).

Steering Committee, International Conference on Glass: 1992 – 1996.

Executive Committee, American Association for Crystal Growth/ West: 1990 – 1996.

Charles Hard Townes Award Committee, Optical Society of America: 1994.

Fellows Committee, Glass and Optical Materials Division, American Ceramics Society: 1992 – 1995 (Chair).

Steering Committee, Crystal Clear Collaboration, CERN: 1992 – 1994

Publishing Technology Committee, Optical Society of America: 1991 – 1993.

N. F. Mott Award Committee: 1983 and 1990.

Nominating Committee, Glass Division, American Ceramic Society: 1988 – 1990

Publications Committee, Optical Society of America: 1986 – 1988.

W. H. Zachariasen Award Committee (Chair): 1989.

**Review Panels:**

Advanced Photon Source, Project Review, Argonne National Laboratory, October 1994.

NSF Academic Research Infrastructure Program, Washington, DC, May 1994

Centers of Excellence Performance Evaluation Panel, Oklahoma City, July 1993.

1-2 GeV Synchrotron Radiation Source, Closeout Review, Lawrence Berkeley Laboratory, May 1993

Leadership Conference, Optical Society of America, New Orleans, LA, January 1993.

Advanced Photon Source, Project Review, Argonne National Laboratory, October 1992.

Centers of Excellence Performance Evaluation Panel, Oklahoma City, July 1992.

Advanced Photon Source, Project Review, Argonne National Laboratory, April 1992.

Leadership Conference, Optical Society of America, Santa Fe, NM, February 1992.

NIH Site Visiting Committee, University of Chicago, November 1991.

Leadership Conference, Optical Society of America, Santa Fe, NM, January 1991.

NSF Site Visiting Committee, Massachusetts Institute of Technology, April 1990.

NSF Science and Technology Centers, Washington, DC, December 1989.

Radiation Effects at the SSC, Berkeley, CA, March 1988.

1-2 GeV Synchrotron Radiation Source, Conceptual Design Review, Lawrence Berkeley Laboratory, July 1986 (technical consultant).

6-GeV Synchrotron X-Ray Source, Conceptual Design Review, Argonne National Laboratory, March 1986 (technical consultant).

ONR Naval Research Laboratory Program Review, Washington, DC, December 1984.

National Academy of Sciences-National Research Council Evaluation Panel, Inorganic Materials Division, National Bureau of Standards, 1974-1976.

NSF Site Visiting Committee, Materials Research Laboratories, 1973 – 1975.

**Department of Energy Workshops:**

Theory and Computer Simulation of Materials Structures and Imperfections, Michigan Technological University, August 1984.

Materials Preparation and Characterization, Oak Ridge National Laboratory, Nov. 1992.

Amorphous Materials, Monterey, California, August 1980.

Thin Film Problems and Research in Energy Systems, Asilomar, CA, November 1976.

**Graduate:**

Raytheon Engineering Management Program, Harbridge House, Boston, 1969.

Raytheon Advanced Management Program, Harbridge House, Boston, 1971.

**Listed in:**

American Men and Women of Science  
Who's Who in Science and Engineering  
Who's Who in Frontier Science and Technology  
Who's Who in Technology Today; Volume 2 – Physics and Optics  
Who's Who in Optical Science and Engineering  
Who's Who in the West

# EXHIBIT B

### **References and Materials Reviewed**

1. *Radiation Detection and Measurements*, 3<sup>rd</sup> edition, G. F. Knoll (John Wiley and Sons, New York, 2000), pages 49 and 231–244. Also 1<sup>st</sup> edition (1978, pages 254–262) and 2<sup>nd</sup> edition (1988, chapter 8, pages 227–240).
2. *Physical Processes in Inorganic Scintillators*, P. A. Rodnyi (CRC Press, Boca Raton, FL, 1997).
3. Experience with scintillators for pet: towards the fifth generation of pet scanners, L. Eriksson, D. Townsend, M. Eriksson, et al., *Nucl. Instrum. Methods Phys. Res. A* 525, 242–248 (2004).
4. Scintillator requirements for medical imaging, W. W. Moses, *Proc. International Conference on Inorganic Scintillators and Their Applications: SCINT99*, Edited by V. Mikhailin (Moscow, Russia, 1999), p. 11–21.
5. The crystal chemistry of the rare-earth silicates, J. Felsche, *Structure and Bonding*, vol. 13, pages 99–197 (Springer-Verlag, Berlin-Heidelberg-New York, 1973).
6. Growth of lanthanide oxyorthosilicate single crystals and their structural and optical characteristics, Anan'eva, et al., *Izv. Akad. Nauk SSSR, Neoorganicheskia Materialy* 17, 754–758 (1981).
7. Crystal growth and optical characterization of cerium-doped  $\text{Lu}_{1.8}\text{Y}_{0.2}\text{SiO}_5$ , D. W. Cooke, J. K. McClellan, B. L. Bennett, et al., *J. Appl. Phys.* 88, 7360–7362 (2000).
8. Properties of LYSO and recent LSO scintillators for phoswich PET detectors, C. M. Pepin, P. Bérard, A-L Perrot, et al., *IEEE Trans. Nucl Sci.* 51, 789–795 (2004).
9. Solid solutions in mineral nomenclature, E. H. Nickel, *Can. Mineral.* 30, 231–234 (1992).
10. A promising new scintillator: cerium-doped lutetium oxyorthosilicate, C. L. Melcher and J. S. Schweitzer, *Nucl. Instrum. Methods Phys. Res. A* 314, 212–214 (1992).
11. European Patent No. 373 976 “Lutetium orthosilicate single crystal scintillator detector.”
12. U. S. Patent No. 6,624,420 “Lutetium yttrium orthosilicate single crystal scintillator detector.”
13. Preparation and cathodoluminescence of  $\text{Ce}^{3+}$ -activated yttrium silicates and some isostructural compounds, A. H. Gomes de Mesquita and A. Brill, *Mat. Res. Bull.* 4, 643–650 (1969).
14. Spectra and kinetics of pulsed cathodoluminescence of  $\text{Y}_2\text{SiO}_5\text{:Tb, Ce}$ , B. V. Shulgin, A. R. Kuleskii, A. M. Korovkin, et al., *Opt. Spectrosc. (USSR)* 68, 491 (1990).
15. Advances in the scintillation performance of  $\text{LSO:Ce}$  single crystals, C. L. Melcher, M. A. Spurrier, L. Eriksson, et al., *IEEE Trans. Nucl Sci.* 50, 762–766 (2003).
16. Thermoluminescence and scintillation properties of rare earth oxyorthosilicates, P. Szupryezynski, C. H. Melcher, M. A. Spurrier, et al., *IEEE Trans. Nucl Sci.* 51, 1103–1110 (2004).
17. [www.photonicmaterials.com](http://www.photonicmaterials.com).



18. Coherent oscillations from  $\text{Tm}^{3+}$ ,  $\text{Ho}^{3+}$ ,  $\text{Yb}^{3+}$ , and  $\text{Er}^{3+}$  ions in yttrium aluminum garnet, L. F. Johnson, J. E. Geusic, and L. G. van Uitert, *Appl. Phys. Lett.* 7, 127–129 (1965).
19. Growth of large  $\text{LYSO}:\text{Ce}$  crystals for scintillation, J-L Lefaucheur, Z. Galazka, Z. Gou, A. Caramanian, P. McDade, published on the conference website at [http://iccg14.inpg.fr/Plenaryabstracts/G03\\_web.pdf](http://iccg14.inpg.fr/Plenaryabstracts/G03_web.pdf).
20. The IMA Commission on new minerals and mineral names: procedures and guidelines on mineral nomenclature, E.H. Nickel and J.D. Grice 1998, *Can. Mineral.* 36, 3–14 (1998).
21. Scintillation properties of selected oxide monocrystals activated with Ce and Pr, A. J. Wojtowicz, W. Drozdowski, D. Wisniewski, et al., *Optical Materials* (in press).
22. Absolute Light Output of Scintillators, M. Moszynski, M. Kapusta, M. Mayhugh, D. Wolski, S. O. Flyckt, *IEEE Trans. Nucl Sci.* 44, 1052–1061 (1997).
23. Large size  $\text{LSO}:\text{Ce}$  and  $\text{YSO}:\text{Ce}$  scintillators for 50 MeV range  $\gamma$ -ray detector, M. Moszynski, M. Kapusta, D. Wolski, et al., *IEEE Trans. Nucl Sci.* 47, 1324–1328 (2000).
24. Comparison of the scintillation properties of  $\text{LSO}:\text{Ce}$  manufactured by different laboratories and of  $\text{LGSO}:\text{Ce}$ , M. Kapusta, M. Moszynski, M. Balcerzyk, et al., *IEEE Trans. Nucl Sci.* 47, 1341–1345 (2000).
25. High efficiency of lutetium silicate scintillators, Ce-doped LPS and  $\text{LYSO}$  crystals, L. Pidol, A. Kahn-Harari, B. Viana, et al., *IEEE Trans. Nucl Sci.*, 51, 1084–1087 (2004).
26. Large size  $\text{LYSO}$  for future high energy physics experiments, R.-Y. Zhu, J. Chen, L. Zhang, abstract *IEEE-NSS 2004*; presentation of J. Chen, L. Zhang, and R.-Y. Zhu.
27. Scintillating properties of  $\text{YSO}:\text{LYSO}:\text{LSO}$  systems, B. H. Chai and D. Y. Chai, poster presented at the annual meeting of the Society of Nuclear Medicine, Toronto (June 18–22, 2005).
28. Fundamental limits of scintillator performance, A. Lempicki, A. J. Wojtowicz, and E. Berman, *Nucl. Instrum. Methods Phys. Res. A* 333, 304–311 (1993).
29. On predicting the maximum efficiency of phosphor systems excited by ionizing radiation, D. J. Robbins, *J. Electrochem. Soc.* 127, 2694–2702 (1980).
30. Efficiency of electron-hole pair production in scintillators, R. H. Bartram and A. Lempicki, *J. Lumin.* 68, 225–240 (1996).
31. Intrinsic trapping sites in rare-earth and yttrium oxyorthosilicates, D. W. Cooke, B. L. Bennett, R. E. Muenchausen, et al., *J. Appl. Phys.* 86, 5308–5310 (1999).
32. See, for example, Positions of 4f and 5d energy levels of  $\text{Ce}^{3+}$  in the band gap of  $\text{CeF}_3$ , YAG, and  $\text{LSO}$ , H. Merenga, J. Andriessen and C. W. E. Van Eijk, *Radiation Measurements* 24, 343–346 (1995).
33. Inorganic scintillators: today and tomorrow. M. J. Weber, *J. Lumin.* 100, 35–45 (2002).
34. A theoretical investigation of 4f–5d transition of trivalent rare earth ions in fluorides and complex oxides, M. Stephan, M. Zachau, M. Gröting, et al., *J. Lumin.* 114, 255–266 (2005).
35. General factors governing the efficiency of luminescent devices, W. M. Yen, *Opt. Mater.* 27, 1647–1652 (2005).

36. Effect of  $^{176}\text{Lu}$  background on singles transmission for LSO-based PET cameras, J. S. Huber, W. W. Moses, W. F. Jones, and C. C. Watson, *Phys. Med. Biol.* 47, 1–7 (2002).
37. *Luminescent Materials*, G. Blasse and B. C. Grabmaier (Springer-Verlag, Berlin Heidelberg, 1994).
38. Revised effective ionic radii and systematic studies of interatomic distances in halide and chalcogenides, R. D. Shannon, *Acta Cryst.* A32, 751 (1976).
39. The spectra of the doubly and triply ionized rare earths, G. H. Dieke and H. M. Crosswhite, *Appl. Optics* 2, 675–686 (1963).
40. Czochralski growth of rare-earth orthosilicates ( $\text{Ln}_2\text{SiO}_5$ ), C. D. Brandle, A. J. Valentino and G. W. Berkstresser, *J. Cryst. Growth* 79, 308–315 (1986).
41. Characteristic Luminescence, G. Blasse and A. Bril, *Philips Tech. Rev.* 31, 304–332 (1970).
42. *Phosphor Handbook*, S. Shionoya and W. M. Yen, editors (CRC Press, Boca Raton, FL, 1999) (pp177-200 and 511).
43. Investigation of some  $\text{Ce}^{3+}$ -activated phosphors, G. Blasse and A. Bril, *J. Chem. Phys.* 47, 5139 (1967).
44. US patent No. 5,003,181 "Method for recording and reproducing a radiation image" (Morlotti).
45. US patent No. 5,264,154 "Single crystal scintillator" (Akiyama et al).
46.  $\text{Nd}^{3+}$  optical centers in lutetium, yttrium, and scandium silicate crystals and their spontaneous and stimulated emission, A. M. Tkachuk, A. K. Przhhevusskii, I. G. Morozova, et al., *Opt. Spectrosc. (USSR)* 60, 176 (1986).
47. Philips 501(k) Submission to FDA Regarding Gemini Raptor.
48. Publicly available marketing literature regarding Philips Gemini Raptor and Gemini TF PET scanners.
49. Publicly available marketing literature and datasheets regarding Saint-Gobain's LYSO Crystal.
50. U.S. Patent No. 4,958,080 "Lutetium orthosilicate single crystal scintillator detector" (Melcher).
51. Prosecution History for U.S. Patent No. 4,958,080.
52. Niraj Doshi's Affidavit and exhibits attached thereto.